

"Error Theory and Data Processing" Course Teaching and Application-Oriented University Measurement and Control Professional Industry Integration Method

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Abstract: The deepening of industry education integration and school enterprise cooperation has put forward higher requirements for the teaching of professional basic courses in applied universities. This paper focuses on the compulsory course "Error Theory and Data Processing" for measurement and control majors, identifies the gap between current course teaching and industry demand, explores the method of curriculum construction for industry integration based on the current teaching situation and existing problems, clarifies the teaching reform goal of deep integration of courses and majors, proposes teaching reform measures suitable for measurement and control majors in applied universities, and solves the problem of insufficient integration of course teaching and professional industry.

Keywords: Industrial Integration; Teaching Reform; Curriculum Teaching.

1. Teaching Status and Existing Problems

Applied universities are the main force in delivering high-level applied talents to China's society. With continuous technological innovation, a large amount of basic work has been replaced by automated machines. Measurement and control majors must closely follow industrial needs and cultivate high-quality measurement and control technical engineers that meet the goals of economic and industrial development planning [1-2]. "Error Theory and Data Processing" is a compulsory course for measurement and control majors, aimed at enabling students to master error theory and data processing methods in mechanical, geometric, and related physical quantity testing techniques, in order to cultivate students' ability to process and analyze measurement results. It is a fundamental knowledge and important ability that high-quality measurement and control technology engineers must possess [3-6]. Therefore, measurement and control majors in application-oriented universities must, on the basis of clarifying the laws of talent cultivation and guided by market demand, carry out teaching reforms on the course of "Error Theory and Data Processing" with industry integration as the main line.

At present, application-oriented universities generally choose the teaching book "Error Theory and Data Processing" (7th edition) edited by Professor Fei Yetai from Hefei University of Technology. This textbook has a comprehensive theoretical explanation and is a classic bibliography that can be widely applied to various majors such as measurement and control technology, instrument science, and automation. However, using comprehensive teaching materials from multiple professional fields for teaching can easily focus on explaining the theoretical content of errors based on textbook knowledge, lacking effective training tailored to the practical application of each major, resulting in insufficient integration of course teaching and professional industries. During the learning process, students may encounter confusion about

"why to use what they have learned" and "how to use what they have learned". Therefore, it is necessary to make appropriate choices and adjustments to the teaching content based on the characteristics of the corresponding industries in this major, add relevant examples and cases of professional industries, introduce real scenes from enterprise sites and production lines into classroom teaching, and adjust teaching resources and requirements to integrate industry elements into the teaching process.

In short, the key to solving the problem of insufficient integration between the teaching of the "Error Theory and Data Processing" course and the measurement and control professional industry is to focus on the integration of industry and education, develop teaching content based on industry elements, improve teaching processes, introduce real scenes from enterprise sites and production lines into the classroom, and carry out course construction and reform guided by work processes and career development.

2. Curriculum Construction Methods for Industrial Integration

2.1. Curriculum Construction Objectives

The ultimate goal of curriculum education should serve the needs of enterprises. Starting from the needs of the enterprise, the training objectives are determined by the needs, the graduation requirements are determined by the training objectives, and then the curriculum system is determined by the graduation requirements. For measurement and control majors in applied universities, the ultimate goal is to cultivate qualified measurement and control technical engineers. Accurate control cannot be achieved without precise measurement, let alone data processing and analysis after measurement. Only by having a clear understanding of the causes of errors and methods for eliminating and reducing them, and having a good grasp of how to obtain accurate and reliable values through data processing, can we truly address measurement and control issues in our work. Therefore, the

goal of curriculum construction should be to solve the problem of insufficient integration between curriculum teaching and professional industries. Focusing on the integration of industry and education, deepening cooperation with enterprises, and jointly building curriculum and teaching resources to meet the needs of the development of measurement and control professionals.

2.2. Course Teaching Content

Applied university measurement and control majors are committed to cultivating applied engineering and technical personnel who can engage in the development, engineering application, operation and maintenance, and modern quality management of automatic detection systems in industries such as instruments and related fields. Therefore, in selecting the teaching content and depth of the "Error Theory and Data Processing" course, it is necessary to combine its own professional characteristics and the needs of corresponding enterprises, and make appropriate adjustments based on the concept of industry education integration, OBE (Outputs Based Education) education concept, and the principle of "learning for application". Industry and enterprise experts and course teaching teams are invited to collaborate to develop the teaching content, re-divide the teaching content from two aspects: theoretical teaching and practical teaching.

1) In terms of theoretical teaching

Error theory involves two major aspects: static measurement and dynamic measurement, with static measurement being the foundation and dynamic measurement developed on the basis of static measurement. Through preliminary research on enterprise needs, it was found that most of the measurements involved in the instrument and meter industry are mainly static measurements. Static measurement mainly includes the identification and processing of three major types of errors, the synthesis and allocation of errors, the processing of linear parameter least squares method, and regression analysis. Therefore, the course teaching should focus more on static measurement and take into account the training characteristics of measurement and control technology engineers, select teaching content, and appropriately reduce the difficulty and requirements. For example, for the chapter on regression analysis in the textbook, only the content of univariate linear regression needs to be the main focus. For multiple linear regression, it is only necessary to expand its application in the form of examples without detailed expansion, so that students can understand the principles and applications of regression analysis. In addition, in the teaching process, the derivation process of complex formulas should be minimized as much as possible to reduce the requirements for students to conduct large amounts of data calculations. Based on practical cases of enterprises, we focus on guiding students to understand and grasp the entire process from correctly organizing the measurement process, to designing and selecting measurement instruments and methods in a reasonable manner, and then to data processing. We also pay attention to cultivating students' innovative thinking.

Therefore, based on the needs of enterprises, this course requires students to master the basic theories and methods of measurement data processing in theoretical teaching. Firstly, learn to analyze and objectively evaluate measurement data from four different perspectives: measurement methods, measurement instruments, measurement environment, and measurement personnel. Secondly, learn to analyze the

comprehensive impact of errors, master the basic laws and methods of error synthesis and distribution, and be able to select measurement instruments reasonably according to requirements, scientifically design testing and evaluation methods. Thirdly, master the principle of linear parameter least squares processing, and learn to use this method to solve data processing problems such as parameter estimation of the most reliable value, combined measurement data processing, and regression analysis.

2) In terms of practical teaching

Go deep into enterprises, visit and investigate the measuring instruments and equipment commonly used by enterprises at this stage, and reasonably simplify the measurement needs of enterprises into the measurement problem of the standard model. Select measurement problem of different ladder difficulty and integrate them into the curriculum system. Invite enterprise experts to participate in practical teaching for specific issues. Explain the importance of error theory to students based on practical cases, as well as the significance of establishing detailed, accurate, and reliable experimental data for the production process. Taking the practical teaching experience of the national first-class major "Measurement and Control Technology and Instruments" under the applied university "Changzhou Institute of Technology" as an example, 9 class hours of practical course teaching can be carried out, including 3 basic measurement practices for the first step difficulty and 3 design measurement practices for the second step difficulty. Among them, for the basic measurement practice of the first step difficulty, conventional measurements such as "measuring simple geometric quantities" can be chosen. It is recommended to arrange it after explaining the theoretical knowledge related to "basic properties and processing of errors", "synthesis and distribution of errors", and "measurement uncertainty". The design-based measurement practice of the second level difficulty can be set according to the actual problems of the corresponding enterprise, such as the measurement of non-geometric quantities such as "sugar content in beverages". It is recommended to arrange it after the practical teaching of the first level difficulty. Setting up experimental courses after studying theoretical knowledge in important chapters will help students have a comprehensive understanding and systematic mastery of the knowledge content, as well as a clearer understanding of the sources of errors in the actual measurement process of enterprises.

Obtaining experimental data through two levels of difficulty measurement practice, ultimately achieving the goal of using points to cover areas and drawing inferences from one example. During the process, students are required to pay attention to the organization of the measurement process, as well as the selection of measurement methods and instruments, in order to improve their ability to analyze and process error sources in response to specific enterprise needs. In addition to practical courses with two levels of difficulty, the teaching team and enterprise experts dynamically adjusted and combined according to students' interests during the operation process, ultimately achieving the optimal integration effect of industry and education.

3. Teaching Reform Measures

3.1. Repositioning Course Objectives

Starting from the training objectives of measurement and control majors in application-oriented universities and

focusing on the cultivation of engineers' professional abilities, combined with the actual needs of enterprises, the course objectives are repositioned based on the principle of "applying what is learned". Enable students to master the basic concepts of measurement error and uncertainty, as well as the basic methods of measurement data processing, while also possessing the ability to correctly select measurement instruments and design measurement plans that are in line with the actual situation of the enterprise. Able to possess certain engineering calculation and design capabilities, and be able to obtain useful information from a large amount of experimental data for data processing.

3.2. Reverse Design Teaching Content

Starting from the practical application of corresponding enterprises and based on the results-oriented OBE education concept, starting from demand, the training objectives are determined by demand, the graduation requirements are determined by the training objectives, and then the curriculum system is determined by the graduation requirements. Finally, the teaching content is designed in reverse by the curriculum system. Introduce complex engineering problems to be solved from the actual needs of the enterprise, and conduct disassembly analysis to sort out the key content of corresponding error theory and data processing. Design teaching content as the core problem to be solved. In the teaching process, emphasis is placed on linking the causes of errors, methods for eliminating errors, and knowledge related to data processing with actual enterprise cases, and on cultivating students' abilities to discover, extract, analyze, and solve practical problems.

3.3. Strengthen Practical Teaching of Courses

By adding six practical tasks with two different levels of difficulty, we aim to improve the teaching process and enhance the connection between course teaching and practical application in enterprises. Add demonstration course teaching design, focus on updating data processing methods and methods, assign extracurricular reference materials and academic paper reading, expand teaching content through these ability training, enhance students independent thinking ability, improve their hands-on ability, and exercise their practical ability.

3.4. Change the Single Assessment Method

Attach importance to the process evaluation model, strengthen the evaluation of students' independent learning and experience, promote the extensionality and openness of the classroom teaching process, and promote the improvement of teaching level and students' learning achievements. Fully utilize modern educational technology and utilize enterprise platforms to introduce real-life scenes from enterprise sites and production lines into the classroom, constructing rich online course resources and interactive links; Increase course practice evaluation to encourage students to better understand the basic concepts and methods of error theory and data processing in practice, and master the use of data processing software.

3.5. Comprehensive Application of Multiple Teaching Methods

Integrating case, practical, and discussion teaching methods. In the classroom teaching, according to the real scene of the enterprise, introduce the application of typical

measuring instruments such as laser interferometer, total station, theodolite, laser tracker, etc. in the production line, and carry out classroom discussion based on their differences in principle and accuracy, so as to improve students' ability to analyze problems. Lead students to observe the working process of the robot vision measurement system on site, explain the measurement principles and error analysis of the system. Realize research feedback teaching, broaden students' horizons, cultivate their innovative awareness, and strengthen the organic integration of curriculum education and professional industries.

4. Conclusion

The deepening of industry education integration and school enterprise cooperation has put forward higher requirements for the teaching of professional basic courses in applied universities. The teaching effect and quality of "Error Theory and Data Processing", as a compulsory course in measurement and control professional education, are crucial for the cultivation of measurement and control technical engineers. Starting from the talent cultivation goals of applied universities, this article examines the gap between current curriculum teaching and industry demand, formulates curriculum goals based on industry demand, optimizes curriculum teaching and practical teaching content based on industry elements, and proposes five practical and effective teaching reform measures. The implementation of the above content will help solve the problem of insufficient integration between curriculum teaching and professional industries, and improve the application ability of error theory knowledge and practical ability of data processing technology for students majoring in measurement and control in applied universities.

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